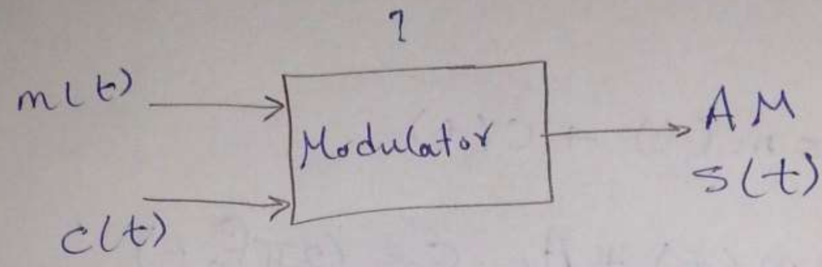
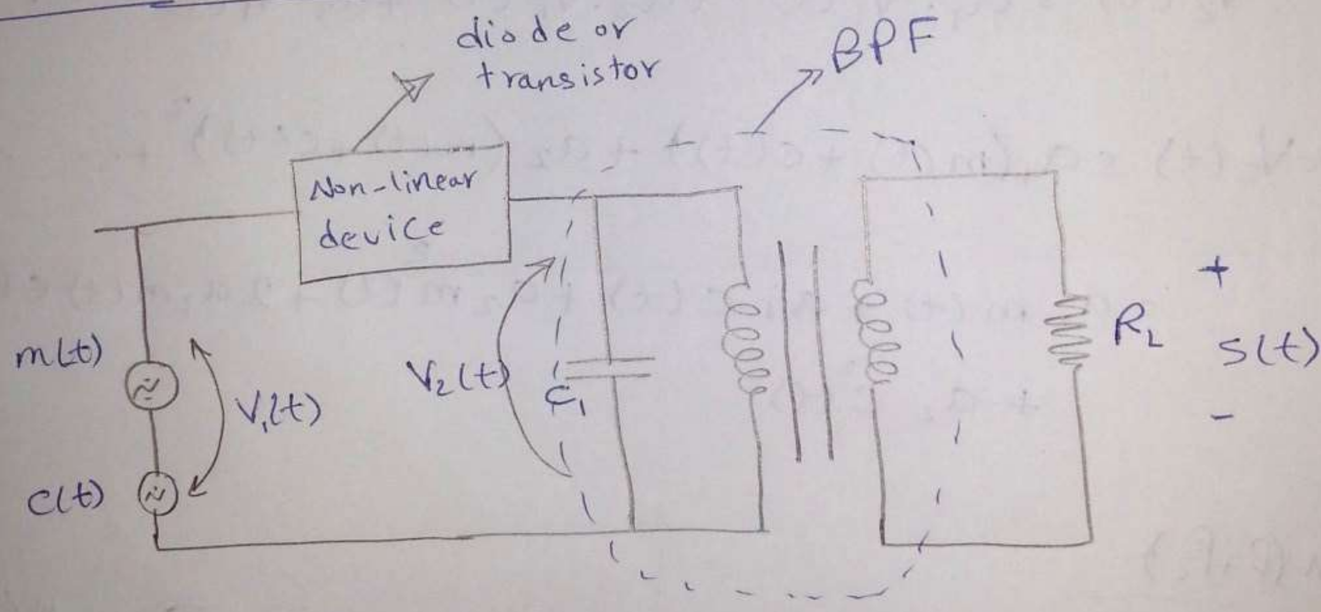
اتصالات
سكشن ٧

1 AM Generation

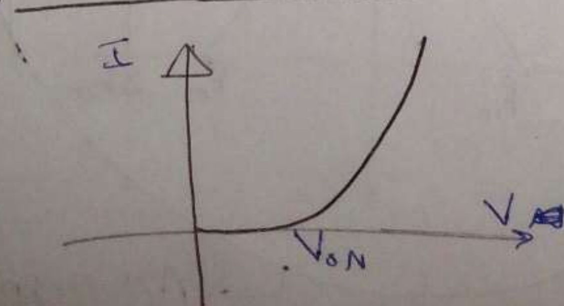
At Tx



1 Square-law modulator



Generation & Detection



* Non Linear device: the relation between it's Voltage & Current is non-Linear (e.g. diode, transistor)

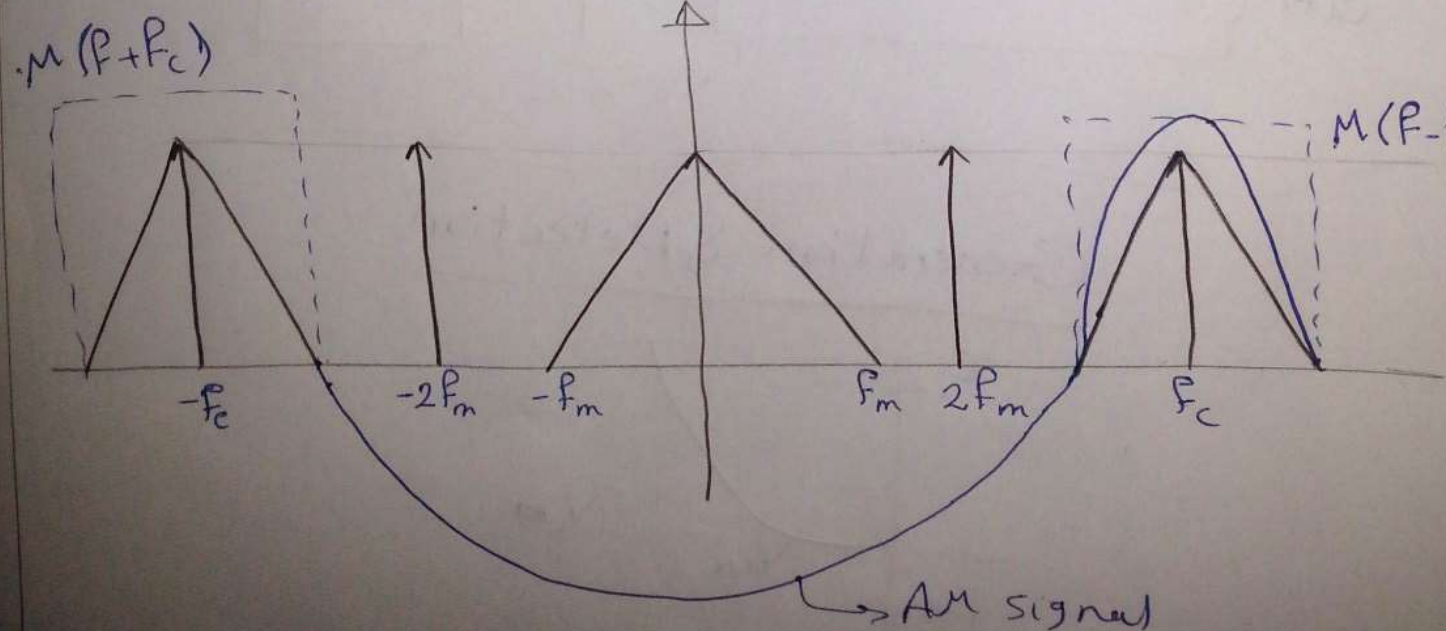
* $V_1(t) = m(t) + c(t)$

$= m(t) + A_c \cdot \cos(2\pi f_c t)$

* $V_2(t) = a_1 \cdot V_1(t) + a_2 \cdot V_1^2(t) + a_3 V_1^3(t) \ldots$

* $V_2(t) = a_1(m(t) + c(t)) + a_2(m(t) + c(t))^2 + \ldots$

$= a_1 m(t) + a_1 c(t) + a_2 m^2(t) + 2a_2 m(t) c(t) + a_2 c^2(t)$



$$m^2(t) = A_m^2 \cos^2(2\pi f_m t)$$

$$m(t) = A_m \cos(2\pi f_m t)$$

$$m^2(t) = \frac{A_m^2}{2}\left(1 + \cos(4\pi f_m t)\right)$$

$$M^2(f) = \frac{A_m^2}{2} \cdot \delta(f)$$

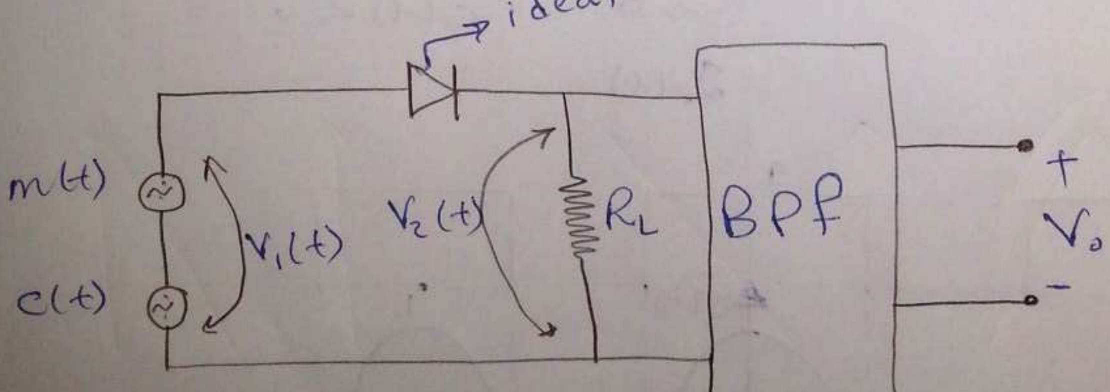
After BPF

$$s(t) = a_1 \cdot c(t) + 2a_2 \cdot m(t) \cdot c(t)$$

$$= a_1 \cdot A_c \cdot \cos(2\pi f_c t) + 2a_2 m(t) \cdot A_c \cdot \cos(2\pi f_c t)$$

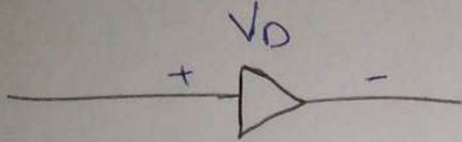
$$= a_1 \cdot A_c\left(1 + \frac{2a_2}{a_1} m(t)\right) \cos(2\pi f_c t)$$

$\boxed{2}$ Switching Modulator



$V_1(t) = m(t) + c(t) \simeq c(t)$

$\mu < 1 \rightarrow \mu = \frac{A_m}{A_c} \rightarrow A_m < A_c$



if: $V_D > 0 \longrightarrow$ Diode on (s.c)

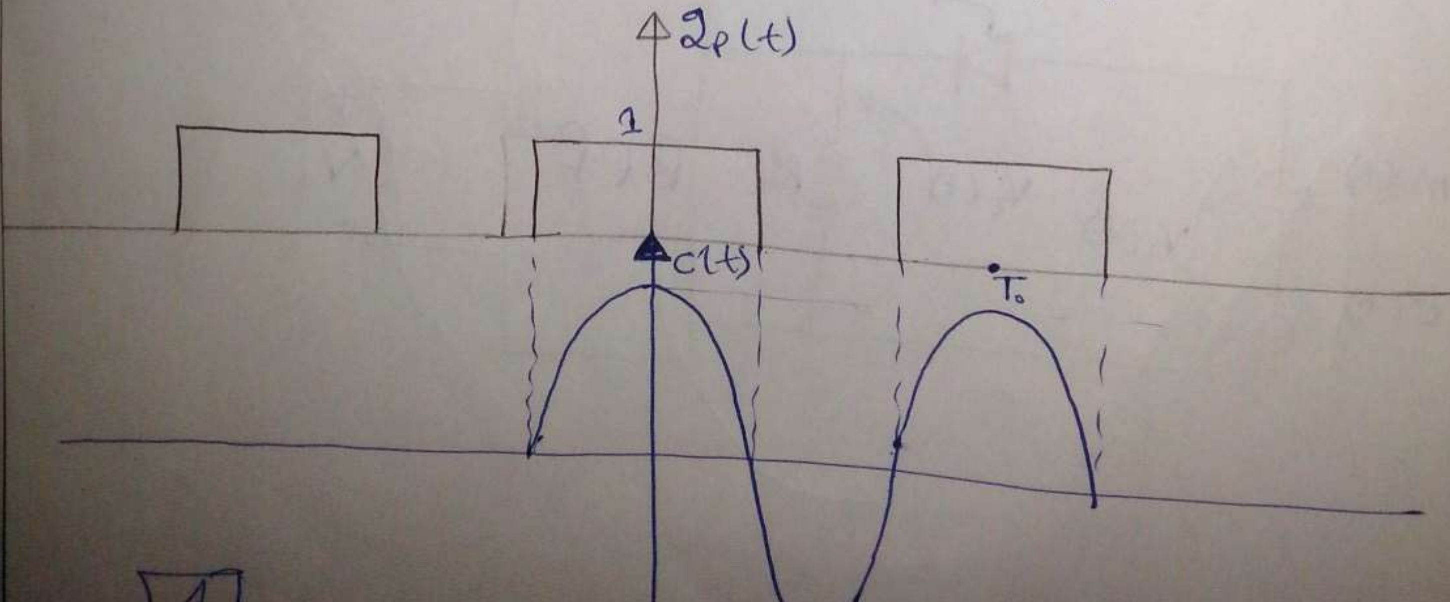
if: $V_D < 0 \longrightarrow$ Diode off (o.c)

$$V_2(t) = \begin{cases} V_1(t) & , c(t) > 0 \\ 0 & , c(t) < 0 \end{cases}$$

* $V_2(t) = V_1(t) * g_p(t)$

$\quad g_p(t) \rightarrow 1 \quad c(t) > 0$

$\quad g_p(t) \rightarrow 0 \quad c(t) < 0$



$$g_p(t) = \frac{1}{2} + \frac{2}{\pi} \cos(2\pi f_c t) + \cdots$$

$$V_2(t) = V_1(t) \cdot \left[\frac{1}{2} + \frac{2}{\pi} \cos(2\pi f_c t) + \cdots\right]$$

$$= (m(t) + c(t)) \left[\frac{1}{2} + \frac{2}{\pi} \cos(2\pi f_c t) + \cdots\right]$$

$$= \frac{1}{2} m(t) + \frac{1}{2} c(t) + \frac{2}{\pi} m(t) \cos(2\pi f_c t) +$$

$$\frac{2}{\pi} c(t) \cos(2\pi f_c t) + \cdots$$

* <u>After BPF</u>

$$V_o = \frac{1}{2} c(t) + \frac{2}{\pi} m(t) \cdot \cos(2\pi f_c t)$$

$$= \frac{1}{2} \cdot A_c \cdot \cos(2\pi f_c t) + \frac{2}{\pi} m(t) \cos(\qquad)$$

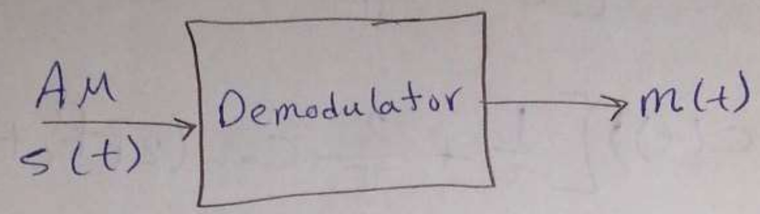
$$V_o = \frac{1}{2} A_c \left(1 + \frac{4 \cdot m(t)}{\pi A_c}\right) \cos(2\pi f_c t)$$

$$s(t) = A_c (1 + K_a \cdot m(t) \cos(\;))$$

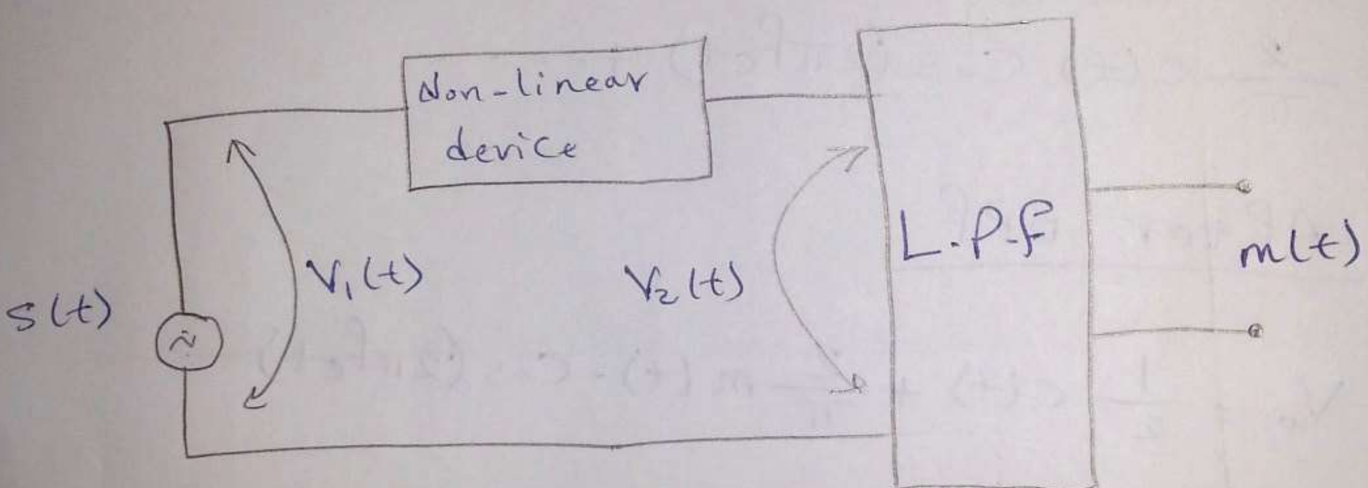
$$\boxed{K_a = \frac{4}{\pi A_c}}$$

2 Demodulator

At R_x



1 square-law demodulator



$$s(t) = V_1(t)$$

$$= A_c\left(1 + K_a \cdot m(t)\right) \cdot \cos(2\pi f_c t)$$

$$V_2(t) = a_1 \cdot A_c\left(1 + K_a \cdot m(t)\right) \cdot \cos(2\pi f_c t)$$

$$+ a_2 \cdot A_c^2\left(1 + K_a \cdot m(t)\right)^2 \cdot \cos^2(2\pi f_c t) \ldots$$

$$\to V_2(t) = a_1 \cdot V_1(t) + a_2 V_1^2(t) + \ldots$$

$$V_2(t) = a_1 \cdot A_c (1 + K_a m(t)) \cos(2\pi f_c t)$$

$$+ a_2 \cdot A_c^2 (1 + 2K_a \cdot m(t) + m^2(t)) *$$

$$\frac{1}{2}(1 + \cos(4\pi f_c t)) \ldots$$

after LPF

$$V_o(t) = a_2 \cdot A_c^2 \cdot 2K_a \cdot \frac{1}{2} m(t)$$

$$= a_2 \cdot A_c^2 \cdot K_a \cdot m(t)$$

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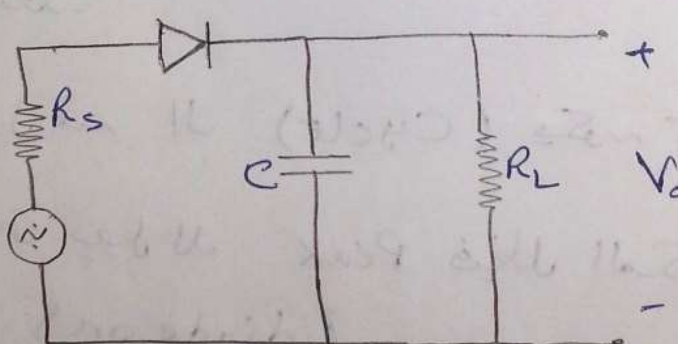
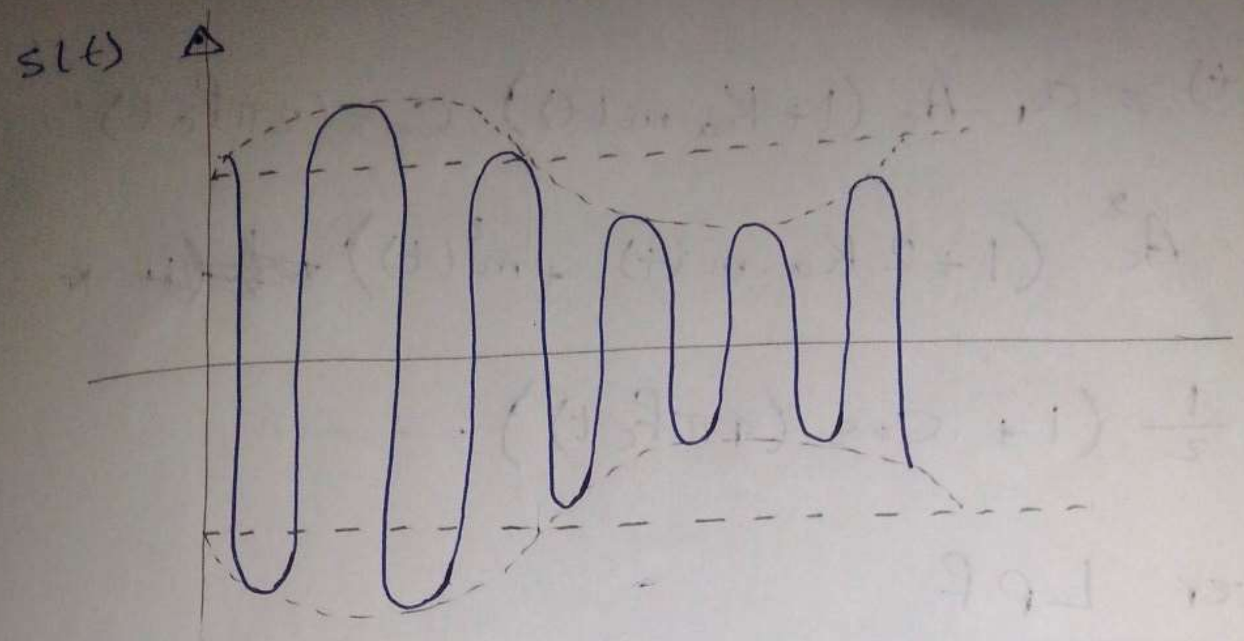
* Envelope detector



→ Envelope detector consists of

1. diode
2. R-C filter



s(t)
$V_1(t)$

← في البداية ال فلو كانت s(t) موجبة ،

يكون ال (diode on) ويصبح S.C والمكثف هيشحن

حتى يصل لهذا الحد.

* في الربع الأول من ال (Cycle) يكون كل نقطة أعلى

من اللي قبلها حتى يصل لل Peak فيظل المكثف يشحن

طالما ال (diode on).

* بعد ال (Peak) يكون النقطة اللي بعدها أقل عنها

Peak < Peak فيصبح ال (diode open) والمكثف يفرغ

في المقاومة حتى يشحن مرة أخرى لما يرجع الجهد يزيد.

Note

$$\tau_{charge} = R_s \cdot C$$

* if τ is high value, C will need much time to charge.

$$R_s \cdot C \ll \boxed{\frac{1}{f_c}} \rightarrow$$ الزمن الدوري للـ ~~Carrier~~ Carrier

← المطلوب أن يكون الشحن سريع.

* $$\tau_{discharge} = R_L \cdot C$$

$$\frac{1}{f_c} \ll R_L \cdot C \ll \frac{1}{f_m}$$

~~Sheet 3~~

$\boxed{9}$ Sec 7